PROJECT OVERVIEW

One of the difficulties in translating travel demand modeling output to photochemical model input is that travel demand volumes must be converted to hourly vehicle volumes. A post-processor, such as the California Direct Travel Impact Model (DTIM), is often used to disaggregate the travel demand model assignments (usually aggregated to 3 or more hours) to the fine grained spatial and temporal resolution required by photochemical models such as EPA's Urban Airshed Model.

To produce fine-grained emissions estimates, travel activities, which are represented both by link and trip end volume assignments, are multiplied by user-supplied emission rates. Estimates of travel activities are usually produced from a travel demand model and DTIM has been designed to accept input from most commonly used models, including MINUTP, TRANPLAN, EMME/2, UTPS, and SYSTEM-II (Caltrans 1994a; Caltrans 1994b). The travel demand model estimated link assignments (or counts on roadway segments) are organized within DTIM into three categories: starts, parks, and stables. The user supplies the hourly conversion factors needed by the program to disaggregate the period-based travel demand link and trip end assignments to hourly summaries.

The factors that are used to convert period to hour determine not only the temporal allocation of emissions but also, if the speed processor is used, the hourly volume for the calculation of volume to capacity (V/C) ratios (Caltrans, 1994b). Thus, the hourly conversion factors become very critical since they determine how the period-based travel demand model link volume assignments are disaggregated to the hourly flow estimates (which in turn determine the hourly emission inventories). Currently the period to hour reduction factors are obtained from travel surveys and applied homogeneously across a region.

Using travel survey data to estimate the proportions of "starts" and "parks" to be assigned to each hour within a period is reasonable since these two activities occur at trip ends, which are recorded in travel surveys. However, the "stable" hourly conversion factors, as defined in DTIM, refer to the vehicle activity that results in "stabilized" exhaust emissions. In other words, the stable period to hour conversion factors apply to that travel activity occurring principally on the network links. Using the travel survey trip end data to estimate the stable activity occurring on the network links is less than ideal and in fact, may be highly unreliable. This method also does not allow spatial variability to be incorporated - all facilities peak at the same hour regardless of the true temporal pattern.

Recently a new method that relies on observed counts to estimate the period to hourly conversion factors for stable emissions has been applied in the South Coast modeling domain. The method is based on a multivariate multiple regression (MMR) model that is specified separately for each time period (e.g., AM peak, PM peak), and uses observed hourly link counts and travel demand model period-based assignments to statistically estimate period to hour conversion factors. Cluster analysis is used to organize count volume locations by similar temporal patterns, which incorporates spatial variability.

To apply the same method in the SJV modeling domain requires some additional thought, principally in terms of how to collect sufficient numbers of counts. In the following discussion, we outline a series of two project phases. The first phase is designed to devise a cost-efficient means of gathering sufficient count data. The second phase focuses on collecting the necessary data and using that data to specify the statistical models. These models are then applied to estimate the factors used to disaggregate period-based travel demand model estimates (e.g., AM and PM peak) to hourly estimates that incorporate both temporal and spatial variation in travel. A brief overview of the two project phases is outlined on the following page along with an approximate cost estimate and timeline, where appropriate.

PHASE 1. ESTABLISH EXPERIMENTAL DESIGN FOR COLLECTING TRAFFIC VOLUMES AND REMOTE SENSING DATA

To perform the new modeling approach, which incorporates spatial and temporal variability in travel for air quality modeling, a large-scale effort must be undertaken to collect traffic volume data. In a region such as the South Coast, where automatic counters are ubiquitous and hourly data is routinely collected, this is less of a problem (e.g., approximately 1400 automatic count locations are located within Caltrans District 7). The effort to collect the same data in the San Joaquin Valley modeling domain would certainly be cost prohibitive.

The alternative is to statistically design a traffic data collection plan that is robust and that identifies the minimum number of traffic counts needed and their locations. The practical problem is how to adequately measure traffic volumes at a large number of locations for a sufficient period of time such that we can infer volumes at times and locations that are not measured. The continuous measurement of count volumes at a large number of locations is relatively expensive, and both the number and location need to be chosen judiciously. Within the SJV modeling domain, the strategy will almost certainly result in a network augmentation of count data regularly collected by Caltrans and others.

The end product of Phase 1 will be an array of detailed experimental designs for collecting traffic count data during the monitoring period. Design considerations must incorporate two major factors. The first factor, which will be addressed in Task 1, is to establish and prioritize the range of desirable outcomes that will ultimately result from the data collection and analysis. The second factor, addressed in Task 2, is the knowledge of the statistical properties of the data of interest. In this case, that will include information about temporal and spatial variability of traffic counts in the area, and correlations between counts across the region. The array of proposed sampling designs will represent the trade-offs between cost and priorities and will take into account availability or loss of modeling information.

Task 1. Establish the Ideal Modeling Parameters

During this first task, working with the various agencies, we will establish the range of desirable modeling interests to be covered in the sampling plan. Modeling interests might include for example, volume counts by weekend or weekday, volume counts by heavy-duty vehicles, volume by all vehicle classes, volume counts for unpaved roads (which could also distinguish between harvest vs. non-harvest flow), volumes by functional class or other location-specific attributes.

Designing a statistical sampling plan requires specification and prioritization of these desirable modeling interests. The initial step after gathering the range of desirable interests is to clearly define what type of data would be ideal given no time or budget constraints. Once this list has been established we can begin to estimate the type and range of actual collection needs as a function of cost and availability or loss of information. Different sampling designs can then be proposed that are tied to optimization of various priorities.

Task 2. Collect, Map, and Analyze Existing Data

This task, underway concurrently with Task 1, will be twofold. It will focus on determining what data sources are currently available, and on collecting some of the existing data within the modeling domain. We'll begin immediately by establishing location and availability of the automatic count data collected by Caltrans. This data collection effort will expand as Task 1 is completed. The purpose is to collect sufficient data to establish the range and variability of traffic in various key locations and to identify where major gaps in knowledge exist.

For this Task, in addition to examining current count data collected, we will solicit data on current and future land use, heavy-duty truck patterns, meteorological trends, local judgement, and key air quality monitoring locations. Using these data, in Task 3 we will be able to identify a smaller subset of sampling than the all-encompassing *all locations, all times*. In other words, using the historical data, facility type identification, local judgement, and current and future travel patterns, we can strategically identify a smaller subset of rotating counts that will suffice for later modeling efforts. For example, in locations where traffic volumes are fairly consistent throughout the year and land use development is minimal, we would expect to need fewer counts during the modeling period. Alternatively, in locations where volumes might vary greatly by time of year or where some specific interest lies in the location, we would anticipate conducting more traffic volume counts.

During this task, we will also establish a GIS-based network map for the modeling domain. This will allow us to create and maintain a visual database of the count data assembled in this task.

Task 3. Experimental Sampling Design

Based on the results of Task 2, we will design various sampling plans aimed at developing a range of sampling options for the Phase 2 study. For example, one extreme might be to conduct a continuous count along every mile of every roadway, while another extreme might be to conduct only a very small set of counts on the highways. A more efficient design will be to allow the network to vary in size and concentration based on the variability of the traffic volumes and the availability of counts from similar locations.

Several geo-spatial techniques have recently been introduced into the statistical literature for augmentation of network size. To use these methods, the existing automated count locations are established as “fixed” and additional times and locations are chosen so that various statistical criteria are optimized, depending on the final objective. Since it is likely that not all of the desirable interests identified in Task 1 can be equally satisfied with a single design, we will use these new techniques to establish an array of network designs with cost estimates for data collection. For example, one network design might provide optimal information regarding truck patterns, while resulting in less than optimal coverage of automobile volumes. The network designs will be based on meeting certain optimality conditions specified by various statistical measures. Designs will almost certainly allow for sequential decisions, altering count locations and times periodically based on information obtained to date. Sequential designs would require that data collection and analysis overlap to create an iterative process.

Task 4. Evaluate Use of Remote Sensing for Inventory Validation and for Inventory Preparation

During this task we will evaluate the use of complementary remote sensing for two purposes. The first is used for small-scale field validation and the second is for preparing a parallel track inventory. We will evaluate the previous use of remote sensing for inventory preparation in Colorado and Atlanta, Georgia. As part of this task, we will compare the advantages and disadvantages of using remote sensing for either purpose and prepare various sampling plans and strategies, with cost estimates for implementation of our recommended strategy.

Task 5. Review and Present Sampling Designs

This task will include review and presentation of the various sampling network designs, including cost and information considerations to the various agencies. We will also include estimates of the costs associated with translating and providing the raw data in CD format. A second iteration through designs may be required based on input in this task. At the completion of this task, we will generate a draft final report, with recommendations for agency review. Work on subsequent phases will not proceed without CARB approval.

Phase 1 Timeline

A draft final report will be completed 5 months from contract initiation. The end product of this first phase will be a detailed experimental design for collecting traffic count data during the monitoring period. ***Timeline: June 1999 - October 1999***

PHASE 2. CONDUCT TRAFFIC MONITORING

In Phase 2 the final data collection of both remote sensing and traffic data will be determined in conjunction with ARB at the completion of Phase 1. It is expected that a significant portion of the data collection will be subcontracted to an outside party. Two types of traffic counts will be collected: 1) data from the automatic count locations managed by Caltrans, and 2) data collected manually. There are several possible technologies for this effort, including use of the standard pneumatic tubes and/or video taping in association with the Autoscope. Obviously as the number of manual count locations increases, the costs can be expected to increase. There will also have be funds for data reduction included in Phase 2. These efforts will be aimed at reducing the data, establishing a database of the raw data, and providing the raw data to CARB. It is anticipated that Phase 2 will be composed entirely of data collection approved by ARB at the completion of phase 1.